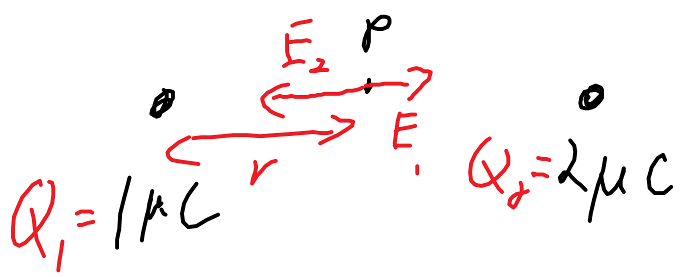
1. A 1.0 μC charge and a 2.0 μC are 0.50 m apart. Determine the electric field strength at
a) Midpoint
b) 0.25 m from the 2.0 μC charge directly away from the other charge
c) 0.25 m above the midpoint (note cosine law/sine law will work)
2. Millikan was able to levitate charged oil drops using charged parallel plates. If the electric field strength between the plates was 4.0×10^4 N/C and the oil drop is 2.0 mg, what is the charge on the oil drop? (Millikan did this thousands of times and determined the charge of the electron)

1a)



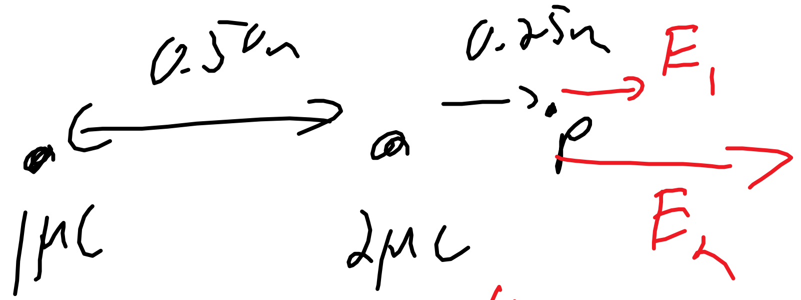
$$E_1 = \frac{kQ_1}{r^2} \qquad E_2 = \frac{kQ_2}{r^2}$$

$$E = E_2 - E_1$$

$$E = \frac{9\times10^9 \frac{Nm^2}{C^2}\, 2\times10^{-6} C}{(0.25m)^2} - \frac{9\times10^9\, 1\times10^{-6} C}{(0.25)^2}$$

$E = 1.44\times10^{5}\ \frac{N}{C}$ towards 1μC charge

b)



Same direction

$E_T = E_1 \oplus E_2$

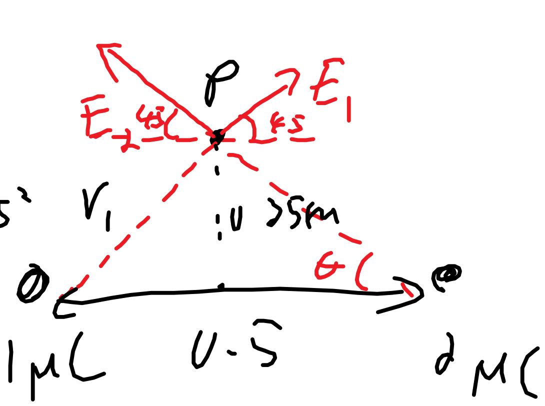
$= \frac{9\times10^9\ 1\mu C}{(0.75m)^2} + \frac{9\times10^9\ 2\mu C}{(0.25)^2}$

16 000 N/C   280 000 N/C

$E_{Total} = 3.04\times10^{5}\ \frac{N}{C}$ to the right

c)

$r_1^2 = 0.25^2 + 0.25^2$



$\tan\theta = \frac{0.25}{0.25}$

$$\tan\theta = \frac{0.25}{0.25}$$

$$\theta = 45°$$

$$E^2 = E_1^2 + E_2^2$$

$$E_1 = \frac{kQ_1}{r_1^2} = \frac{9\times10^9(1\times10^{-4})}{(0.15^2+0.25^2)}$$

$$= 7.2\times10^4 \text{ N/C}$$

$$E_2 = 1.44\times10^5 \text{ N/C}$$

$$E = \sqrt{E_1^2 + E_2^2}$$

$$= \boxed{1.6\times10^5 \text{ N/C}}$$

$$\tan\phi = \frac{E_1}{E_2}$$

$$\phi = 26.6°$$

$$\frac{+45}{72^\circ}$$ up from line between charges.

#2

$\uparrow F_e = Eq$

q ○ $m = 2\,mg$

$\downarrow F_g = mg$

$$E = 4.0 \times 10^4 \, \frac{N}{C}$$

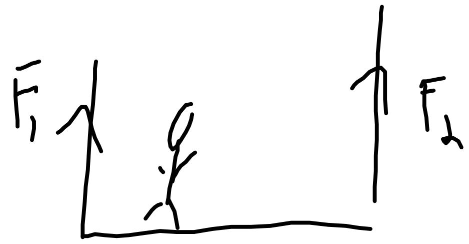
$$Eq = mg \qquad mg \rightarrow kg$$

$$q = \frac{2 \times 10^{-6}\,kg \; 9.8\,\frac{N}{kg}}{4 \times 10^4\,\frac{N}{C}}$$

$$\boxed{q = 4.9 \times 10^{-10}\,C}$$

Electrostatic Energy and Voltage
After Spring Break
Quiz next class electrostatics Ch 16
marked in class
Statics electrostatics test March 2nd
Term test March 10th

Q3



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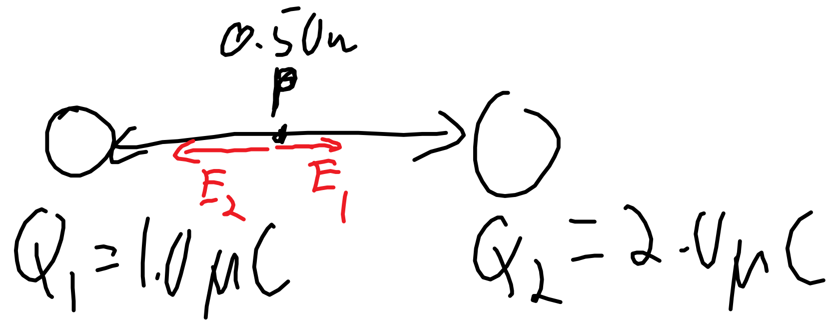


E at p = ?

$E = \frac{kQ}{r^2}$

$E_{total} = E_2 - E_1$

↑ opposite directions

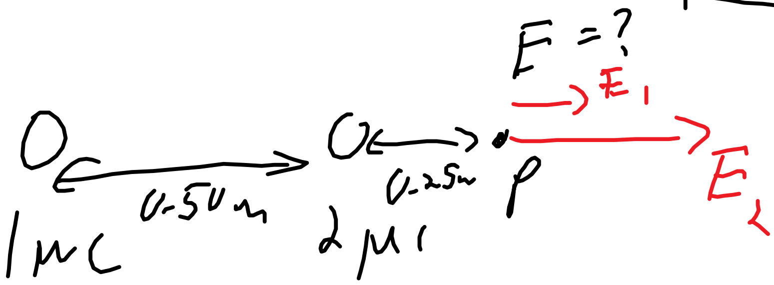
$$E = \frac{kQ_2}{r_2^2} - \frac{kQ_1}{r_1^2}$$

$$E = \frac{9\times10^9 \frac{Nm^2}{C^2}\, 2\times10^{-6}\,C}{(0.25m)^2} - \frac{9\times10^9 \frac{Nm^2}{C^2}\, 1\times10^{-6}\,C}{(0.25m)^2}$$

$$\boxed{E = 1.44\times10^5 \frac{N}{C}}$$

to the left – from 2μC to 1μC

b)



$$E_{total} = E_1 \oplus E_2$$

↑ same direction

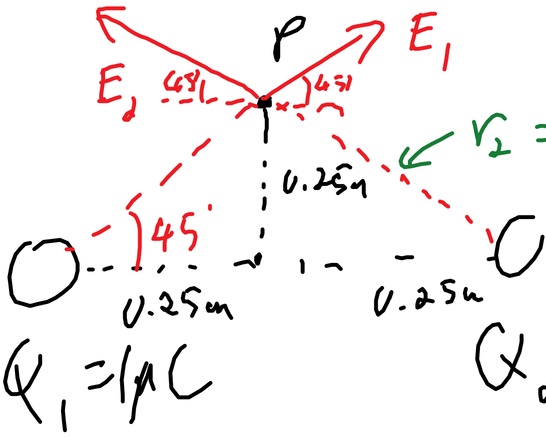
$$= \frac{9\times10^9 \frac{Nm^2}{C^2}\, 1\times10^{-6}\,C}{(0.75m)^2} + \frac{9\times10^9\, 2\times10^{-6}}{(0.25m)^2}$$

$$= 16\,000 \frac{N}{C} + 288\,000 \frac{N}{C}$$

[illegible] $\times10^5$ N/C to the

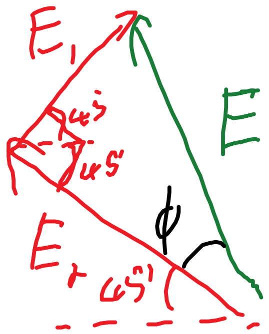
$= \boxed{3.04 \times 10^5\ N/C \text{ to the right}}$

c)



$r_2 = \sqrt{0.25^2 + 0.25^2}$

$= 0.35 m$



$E = \sqrt{E_1^2 + E_2^2}$

$$E_1 = \frac{9 \times 10^9 \; 1 \times 10^{-6}}{0.3535^2} = 7.2 \times 10^4$$

$$E_2 = 2E_1 = 144000$$

$$E = \sqrt{7.2^2 + 14.4^2} \times 10^4$$

$$\boxed{E = 1.6 \times 10^5 N/C}$$

$$\boxed{\vec{E} = 1.6 \times 10^5 \, N/C}$$

$$\tan\phi = \frac{E_1}{E_2} = 0.5$$

$$\phi = 26.6^\circ$$

$+45^\circ$

$\boxed{72^\circ}$ above the line between charges towards 1 μC

2

$q = ?$

↑ $F_e = Eq$

(q) $m = 2\,mg$

↓ $F_g = mg$

$E = 4 \times 10^4 \, \frac{N}{C}$

$$F_e = F_g$$

$$Eq = mg$$

$$q = \frac{mg}{E}$$

mg → kg

$$q = \frac{2 \times 10^{-6}\,\text{kg} \;\; 9.8\,\text{N/kg}}{4 \times 10^{4}\,\text{N/C}}$$

$$q = 4.9 \times 10^{-10}\,\text{C}$$